3. CIVIL AND ENVIRONMENTAL ENGINEERING

Program Outcomes and Assessment

The Task Force that designed the Michigan Curriculum 2000 examined the recommendations of numerous national studies on engineering education, including those produced by the National Research Council, American Society for Engineering Education and the Accreditation Board for Engineering and Technology. Input was also sought from students and alumni and from the College's National Advisory Committee. As a result, the program outcomes of MC 2000 are almost identical to those of ABET EC 2000.

3.1 Program Outcomes

Civil and Environmental Engineering Educational Outcomes

(a) An ability to apply knowledge of mathematics, science, and engineering within civil and environmental engineering

(b) An ability to design and conduct experiments, and to critically analyze and interpret data

(c) An ability to design a system, component or process to meet desired needs

(d) An ability to function in multi-disciplinary teams

(e) An ability to identify, formulate and solve engineering problems

(f) An understanding of professional and ethical responsibility

(g) An ability for effective oral, graphic, and written communication

(h) An understanding of the impact of engineering solutions in a global and societal context

(i) A recognition of the need for, and an ability to engage in life-long learning

(j) A knowledge of contemporary issues that affect Civil and Environmental Engineering

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

(l) A proficiency in a minimum of four major civil and environmental engineering areas

(m) An understanding of professional practice issues and the importance of licensure.

3.2 Relationship of Program Outcomes to Educational Objectives

Objective 1 is associated with outcomes a, b, i, l:

The ability to apply knowledge in math, science and engineering helps achieve a solid foundation in Civil and Environmental Engineering while enabling students to have a broad spectrum of dynamic career opportunities, which become possible by life-long learning. Proficiency in scientific, engineering and design aspects of infrastructure and environmental systems is achieved by designing and conducting experiments, and analyzing and interpreting data. To properly address the broad spectrum of infrastructure and environmental problems, a proficiency in several specialty fields within the program is necessary.

Objective 2 is associated with outcomes c, d, e:

The ability to function in a multi-disciplinary team, to design a system and its components, and to identify and solve engineering problems help achieve teamwork experience, open-ended problem solving skills, and critical thinking.

Objective 3 is associated with outcomes g, k:

The skills for effective communication are acquired by proficiency in written, oral, visual, and graphical techniques. In addition, modern engineering tools, such computing and visualization software make communication more effective.

Objective 4 is associated with outcomes f, h, j, m:

Professional and ethical responsibility, impact of engineering solutions on global and societal problems, knowledge of contemporary issues, and the understanding of professional issues help achieve an awareness of moral, ethical, legal and professional obligations to protect human health, human welfare, and the environment.

3.3 Achievement of Program Outcomes

The department of Civil and Environmental Engineering assures student achievement of program outcomes through a combination of curricular design and program assessment measures. The program outcomes are mapped onto the program curriculum by means of 26 courses administered by the CEE department. 15 other courses are essential to the curriculum and are also subject to assessment measures. Their modification, however, is not achieved directly. For example, selected CoE faculty serve as math and science liaisons. Their role is to interact with the corresponding programs in the Literature, Sciences and Arts school, to report problems and to help achieve the CoE's objectives. For engineering courses originating in other CoE departments, modifications are performed by the home department. The CEE member in the MC 2000 task force acts as

a contact person between the two departments. Finally, the CEE program offers numerous other courses that can be taken by the students as free electives. Although these courses are also assessed by the same processes as the 26 core courses, their contribution to program outcomes is not presented here because there is no guarantee that any given student will take those courses.

3.3.1 General Description of Assessment Plan

Course assessment is performed on an annual basis during the month of May, which is devoted to curriculum assessment and improvement. Classes for the Winter semester are over by April 30, however, the faculty's academic appointments cover the month of May for the purpose of course improvement and modification. As shown in Figure 3.1, the process originates with the strategic plan, which establishes program objectives and outcomes.

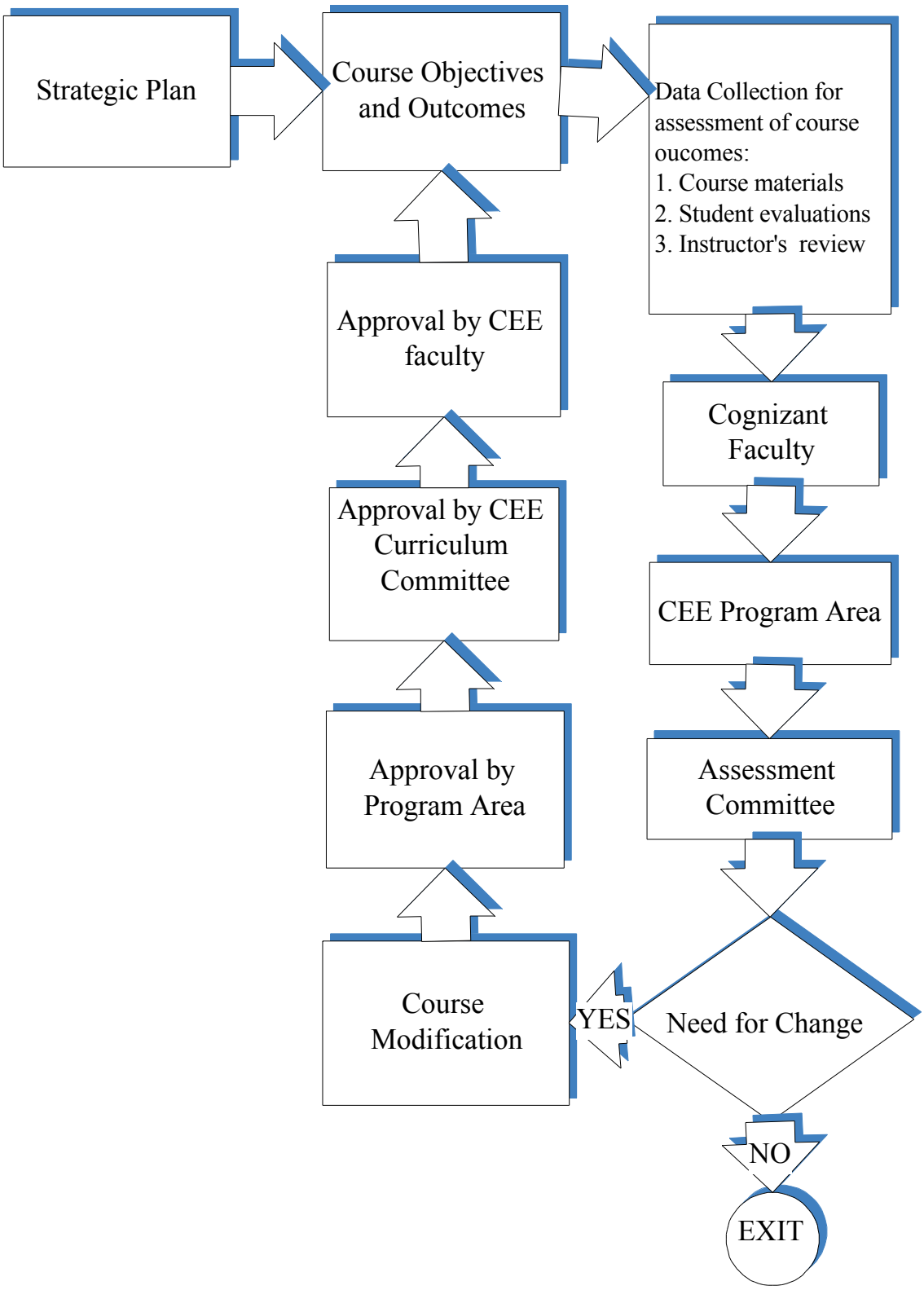

Figure 3.1. Course Assessment Process

Each of the 26 program courses that directly affect the undergraduate curriculum are mapped against the 13 program outcomes, as shown in Table 3.1. In addition, each course has published course objectives and outcomes. The cognizant faculty for each course are responsible for defining the objectives and outcomes, and identifying tools for their assessment.

The annual assessment cycle is initiated by collection of student materials, grades, and student evaluations. Each of the 26 courses has a unique student evaluation set of questions designed by the cognizant faculty. Table 3.2 shows the exact question mapping to the university's evaluation unit. The numbers on this matrix are selected by the cognizant faculty among 1,000 available questions, such that each outcome of the course can be directly assessed.

The course instructor for the particular term writes an assessment report, which is submitted to the cognizant faculty, if they are different. Otherwise, the cognizant faculty submits the report directly to the CEE program area in charge of the course for review and evaluation. These are: Construction Engineering and Management, Environmental and Water Resources Engineering, Geotechnical Engineering, and Structural and Material Engineering. The program areas evaluate the individual courses and examine how each course fulfills the objectives and outcomes of the program area. Their findings are forwarded to the assessment committee, which decides if any course modifications are necessary. The recommendation is returned to the program area, the course is modified accordingly, and approval is sought by the CEE curriculum committee, the CEE executive committee, the CEE faculty, the CoE curriculum committee, and finally the CoE faculty. This completes the cycle of course assessment and modification.

The key element of the course outcome assessment process is embedded in Table 3.1. The development of the program course outcome matrix required an effort of entire CEE faculty that lasted almost eighteen months. Each faculty was asked to create a template, which besides the course description and list of topics, specifies individual course objectives, course outcomes and the tools necessary for the assessment of outcome achievement. The individual templates were approved by the various program areas within the department to assure that course contents and objectives were compatible with the goals of the program areas. Each program area submitted the templates to the assessment committee, which assembled the course outcome matrix. The goal was to create a curriculum with strong correlation of course outcomes and program objectives. This required several iterations and was further complicated by the fact that the curriculum was also undergoing a transition at the same time. As mentioned earlier, it required twelve revisions to arrive at the present form of the curriculum. In the process, new courses were created, others were abandoned, and several old elective courses became required.

During the curriculum revision process, it became apparent that adhering to the 4 x 4 x 8 model suggested by MC 2000 for all four undergraduate years, was imposing a disproportionate burden to the graduate program. Many first-year graduate students take

several 400-level courses for graduate credit, and several technical electives are actually 500-level courses, i.e., graduate course. Since the Masters of Science in Engineering program consists entirely of 3-credit hour courses, it became evident that maintaining the technical electives at 3-credit hours was the optimum choice. This works well with the continuously growing Simultaneous Undergraduate-Graduate degree program in the department, and it allows room for the 1-credit hour course on professional issues, which seemed difficult to cover by other means.

Particular effort has been made to identify in the course outcome matrix the subjects covered not by a single course, but rather in the form of the various threads in the program. These are lifelong learning, team-building, technical communication, and professional ethics. The college of engineering has several full-time consultants on its staff for supporting individual faculty members in implementing the threads across the curriculum. These are provided in the form of manuals, internet links to courses, workshops and tutorials. Technical Communication is of course a separate program in the CoE, and its staff is actively involved in the instruction of the three CEE courses designated as anchors for that thread. Finally, the environmental awareness thread is not addressed specifically since a significant part of the curriculum is associated with related subjects.